MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210)

EEN1046 –ELECTRONICS III

(TE / RE)

9 FEBRUARY 2023
9.00 a.m. - 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages excluding the cover page with 4 Questions only.

2. Answer ALL questions . All questions carry equal marks and the distribution of the marks for each question is given .

3. Please write all your answers in the Answer Booklet provided .

Q1.

(a) State four differences between an ideal op amp and practical op amp.

[4 marks]

(b) (i) Draw the circuit of non-inverting amplifier with the aid of 2 resistor R_f and R_i and an input of V_i. Hence, find the closed loop gain of this circuit. [4 marks]

(ii) Given R_f and R_i is 200kΩ and 10kΩ respectively, calculate the close loop gain of this non-inverting op amp. [2 marks]

(c) Design the multistage amplifier circuit as shown in Fig. Q1 with desired output $V_o = 3(V_1 + V_2)$ by applying 2 op-amps and 7 pieces of 10 kΩ resistors only. Assume all components are ideal.

[7 marks]

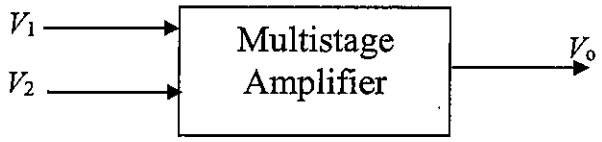

Fig. Q1: Multistage Amplifier

(d) A bandpass filter has Q=20 and Bandwidth = 10kHz. Calculate f_H, f_L and f_o.

[5 marks]

(e) A low-pass 2nd order filter with center frequency fc = 10kHz has -40dB/decade attenuation. Determine the normalized gain A_v in dB at f = 50kHz. [3 marks]

Continued ...

Q2. (a)A filter has a voltage transfer function of

$$H(s) = \frac{\frac{1000}{s}}{\frac{4x10^6}{s^2} + \frac{100}{s} + 1}$$

Determine the type and order of this filter. Hence, calculate the value of K, Q and ω_o. [6 marks]

(b) Design a unity gain Butterworth 2nd order high pass filter using Sallen key network with fc= 10kHz.
The choice of resister used should be ≥10kΩ. Draw the high pass filter circuit and label the resistor value accordingly. [7 marks]
Hint: the circuit has equal resistor value but different capacitor values.

(c) Explain the reason of occurrence of input bias current (I_B) and input offset voltage (V_{IO}) in practical op amp. [5 marks]

(d)

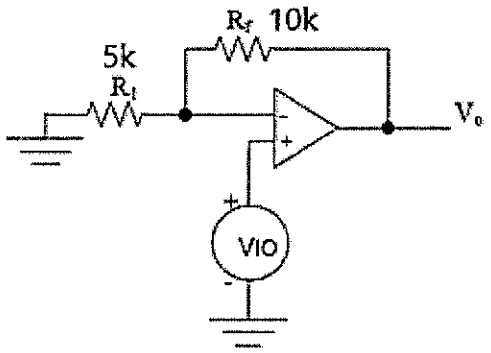

Figure Q2)

Consider the above op-amp circuit in figure Q2, calculate the output offset voltage due to input bias current (V_{os1}), the output offset voltage due to input offset current (V_{os2}), the output offset voltage due to input offset voltage (V_{os3}) and the total output offset voltage (V_{os}). Assume the op-amp LM358 is used (input offset current=50nA, input bias current=125nA, input offset voltage=5mV). [7 marks]

Continued ...

Q3 (a) Define slew rate. [2 marks]

(b) Given the supply voltage changes from $V_{DC} = \pm 20V$ $to\ V_{DC} = \pm 15V$ and input offset voltage per unit change in the dc supply voltage is 1000uV. Find the PSRR in dB. [2 marks]

(c)

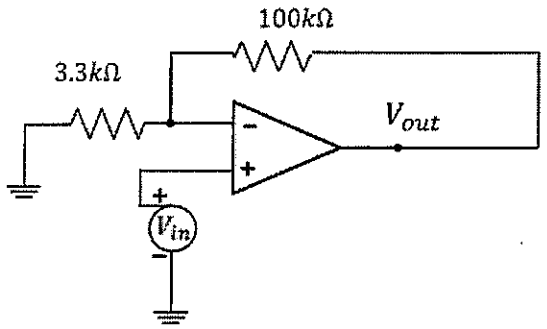

Figure Q3(a)

Calculate the closed loop bandwidth for the non-inverting amplifier shown in Figure Q3(a). The unity gain bandwidth offered by above op amp is 10MHz. [3 marks]

(d) Explain the function of voltage regulator. [2 marks]

(e) Figure Q3(b) below shows the basic series regulator. Explain how this regulator functions when the output V_o increases (decreases). [5 marks]

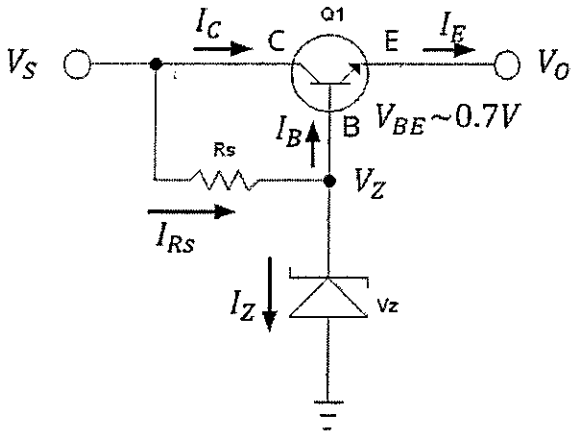

Figure Q3(b)

Continued ...

Q3(f) Figure Q3(c) is basic series regulator while figure Q3(d) is basic shunt regulator. Both regulator has output $V_o = 10V$, $V_s = 15V$, $I_Z = 10mA$, $h_{FE} = 100$, $Rs = 10\Omega$ and $R_L = 100\Omega$.

Compare the efficiency of both regulator. Which regulator is more efficient? [11 marks]

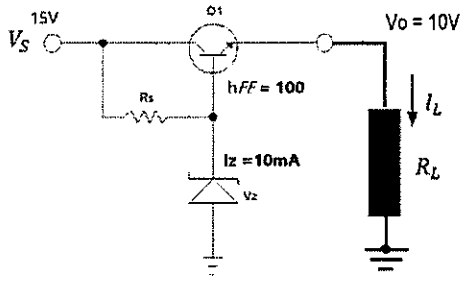

Figure Q3 (c)

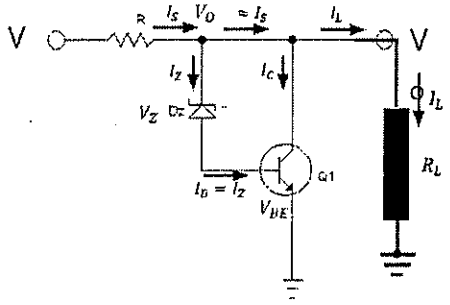

Figure Q3(d)

Q4 (a) Sinusoidal oscillation must fulfil Barkhausen Criterion. Define Barkhausen Criterion. [2 marks]

(b) Given the attenuation β of the Wien Bridge oscillator as follow:

$$\beta = \frac{X_C R}{(3RX_C) + j(R^2 - X_C^2)}$$

Find the equation of f_o in term of R and C. Hence, find the value of β . What should the loop gain A_v in order to fulfil Barkhausen Criterion. [5 marks]

Hint: β is real value and $X_C = \frac{1}{2\pi fC}$

(c) Figure Q4 below is the phase shift oscillator. Determine the value of R and C if this oscillator operates at $f_o = 1kHz$ and $R_f = 100k\Omega$. Calculate the phase shift of this oscillator (the last RC network closest to the input). [5 marks]

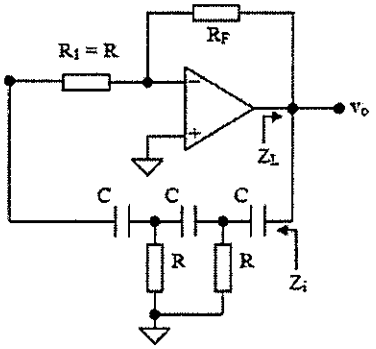

Figure Q4

Continued ...

Q4(d) Design a Colpitts oscillator with an oscillation frequency of 10kHz.
Draw the Colpitts oscillator circuits with the components labelled. [8 marks]

Hint: both the capacitors value is equal.

(e) If a 3 bit Analog to Digital converter is used to convert 16V input signal. Calculate the resolution of the input signal. Suggest 2 methods to increase the resolution of the ADC.
[5 marks]

APPENDIX 1

Filter type	k_0, k_1, k_2	Voltage transfer function
Low-pass	1, 0, 0	$H_{LP}(s)=\frac{K\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
High-pass	0, 0, 1	$H_{HP}(s)=\frac{Ks^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-pass	0, 1, 0	$H_{BP}(s)=\frac{K(\omega_o/Q)s}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-reject	1, 0, 1	$H_{BR}(s)=\frac{K(s^2+\omega_o^2)}{s^2+(\omega_o/Q)s+\omega_o^2}$
All-pass	1, -1, 1	$H_{AP}(s)=K\frac{s^2-(\omega_o/Q)s+\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$

Biquadratic voltage transfer function (2nd-order system)

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